

SEPTEMBER 2019



**WIM #49
I-90,
MP 42.6
WORTHINGTON,
MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #49 is located on I-90 near Worthington in Nobles county.

System Operation

WIM #49 was operational for the entire month of September 2019. Volume was computed using all monthly data.

System Calibration

WIM #49 was most recently calibrated on 2019-01-24. Table 1 summarizes the front axle weights of class 9s by lane ¹. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation ². Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 359424 | Passenger Vehicles: 300014 | Heavy Commercial Vehicles: 59410

Monthly Average Daily Traffic (MADT): 11974 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 1980

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. EB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Tuesdays. WB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Wednesdays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), EB PVs generally reached peak volume levels between 02 PM and 04 PM. Similarly, WB PVs peaked in volume between 02 PM and 04 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 02 PM and 04 PM, while volume going WB peaked between 02 PM and 04 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 59410 HCVs, 1298 of them were overweight ³. These overweight HCVs contributed to 0.4% of total monthly volume, and 2.3% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Wednesdays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 62.2% of all overweight vehicles traveling EB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in November.

WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report ⁴.

Using normal load limits ,405 EB vehicles exceeded 88,000 pounds (357 vehicles were Class 9's; 25 vehicles were Class 10's). Of vehicles traveling WB,

41 EB vehicles exceeded 88,000 pounds (29 vehicles were Class 13's; 6 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in September 2019. Data suggests that there were greater numbers of empty Class 9's than fully_loaded Class 9's traveling EB, while there were more empty Class 9's than fully_loaded traveling WB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more empty class 10 vehicles.

Freight Totals. A total of 428197 tons of freight was recorded to have crossed the WIM. More freight was shipped WB (52.6%) than EB (47.4%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 53815 and 53816 (Prestressed Beam Span) are approximately .18 miles east of WIM #49. Bridge No. 53813 and 53814 (Prestressed Beam Span) are approximately .43 miles west of WIM #49. WIM #49 recorded a total of 359424 vehicles with a combined GVW of 3668276 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 31489 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 50% of all ESALs were recorded WB while 50% was observed EB. In particular, 83% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 53% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:

<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

classification scheme and vehicle class groupings for traffic forecasting can be found at:
<http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ±9% of baseline calibration values
- ² Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.
- ³ An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes:
http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp
- ⁴ For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

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Figure 1 - Monthly Class 9 GVW Histogram

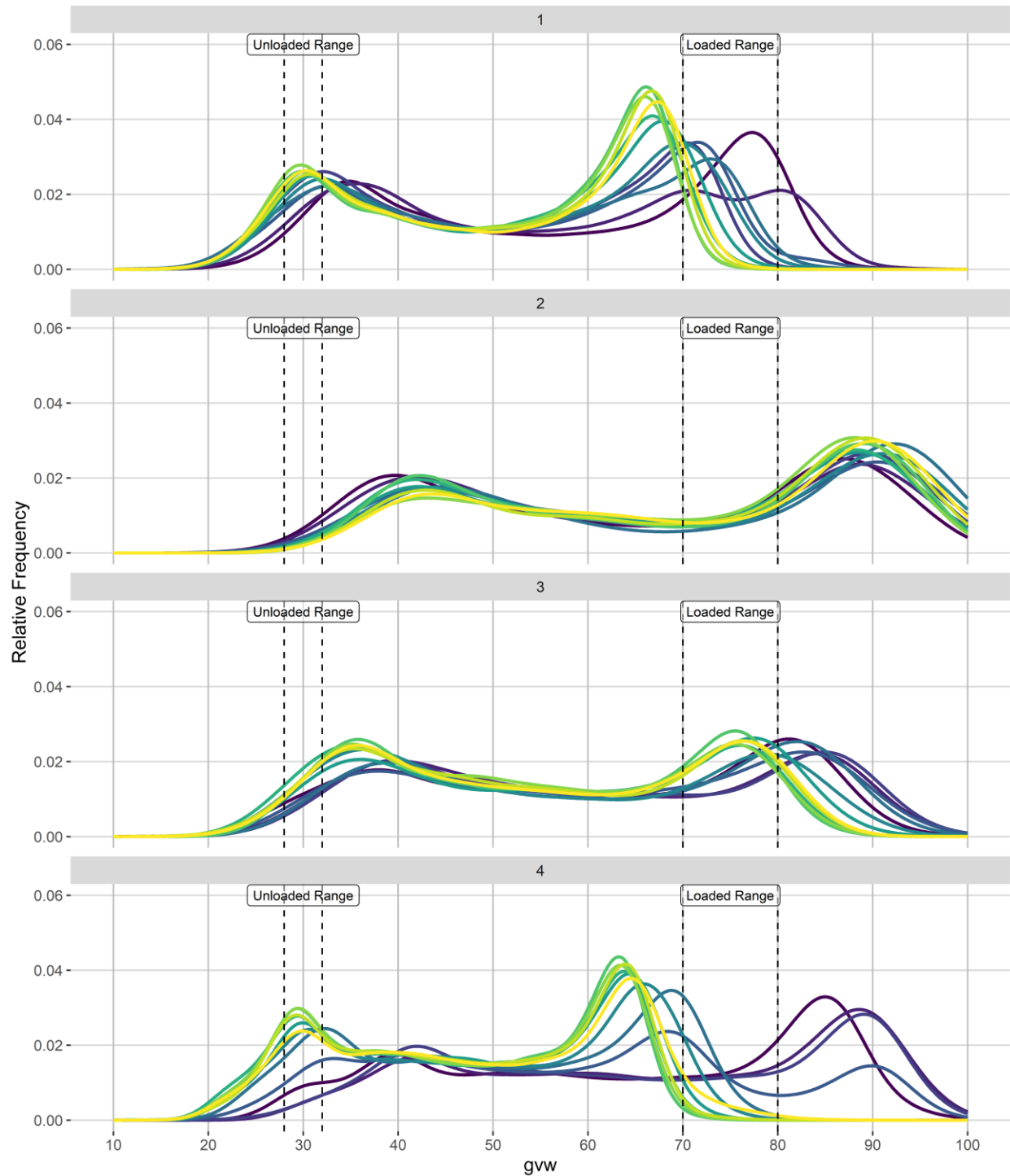
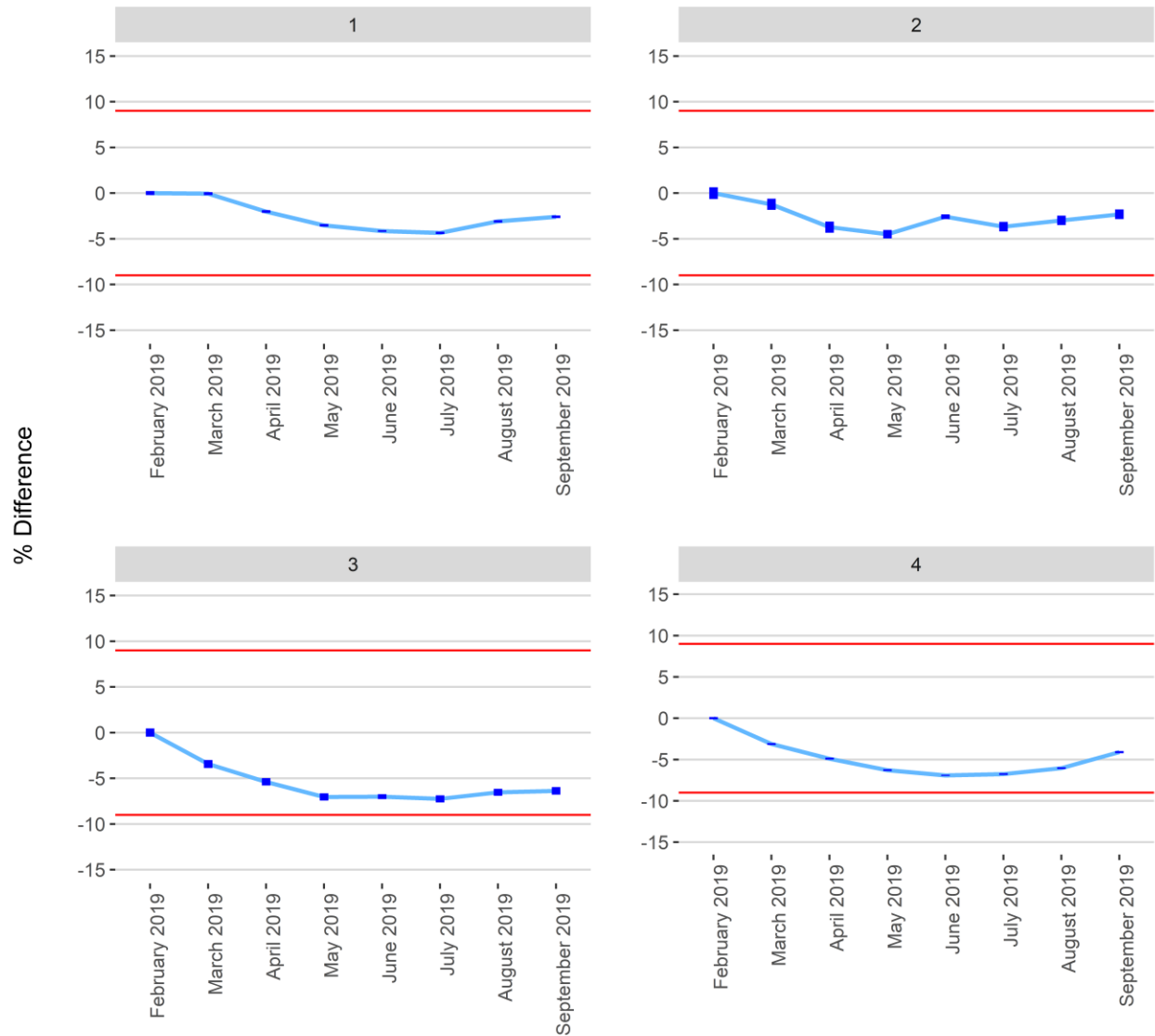


Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume
vs. Day of the Week

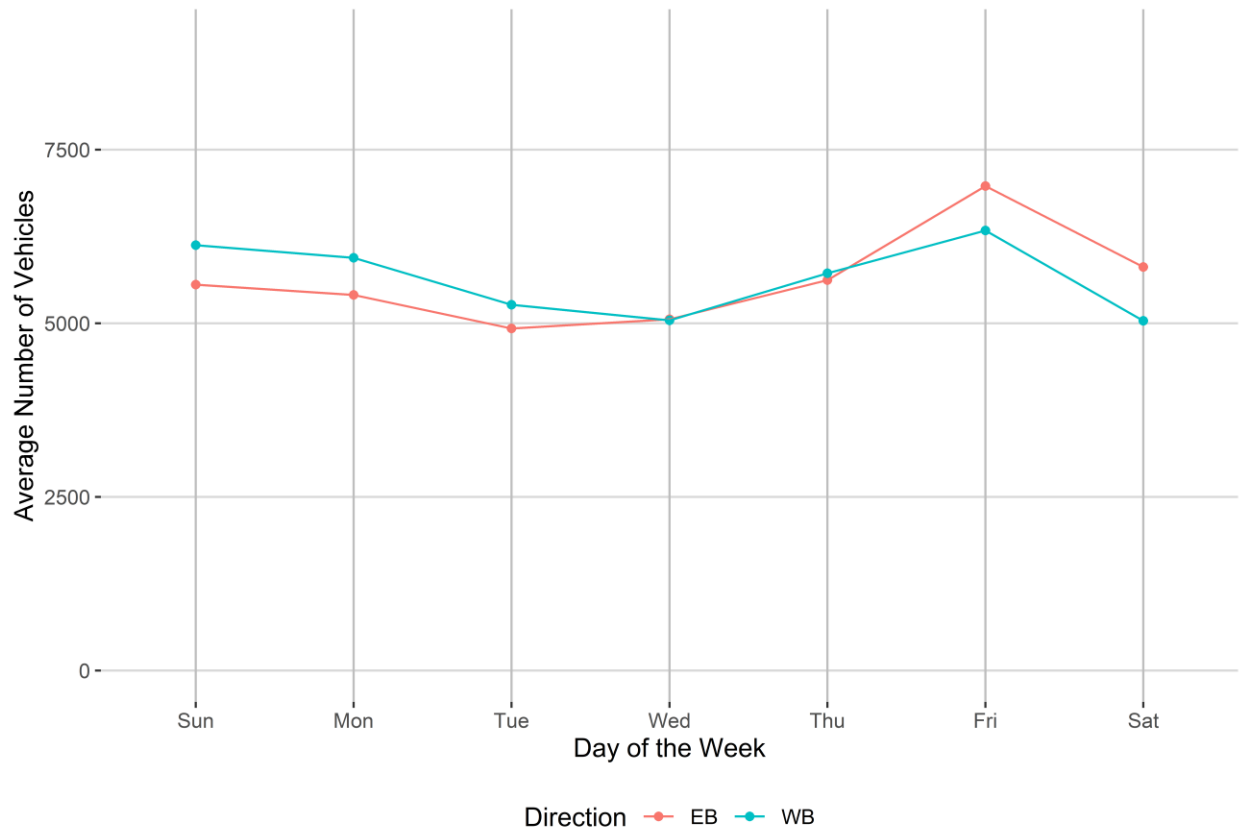


Figure 3 - Average Overweight Vehicle Volume
vs. Day of the Week

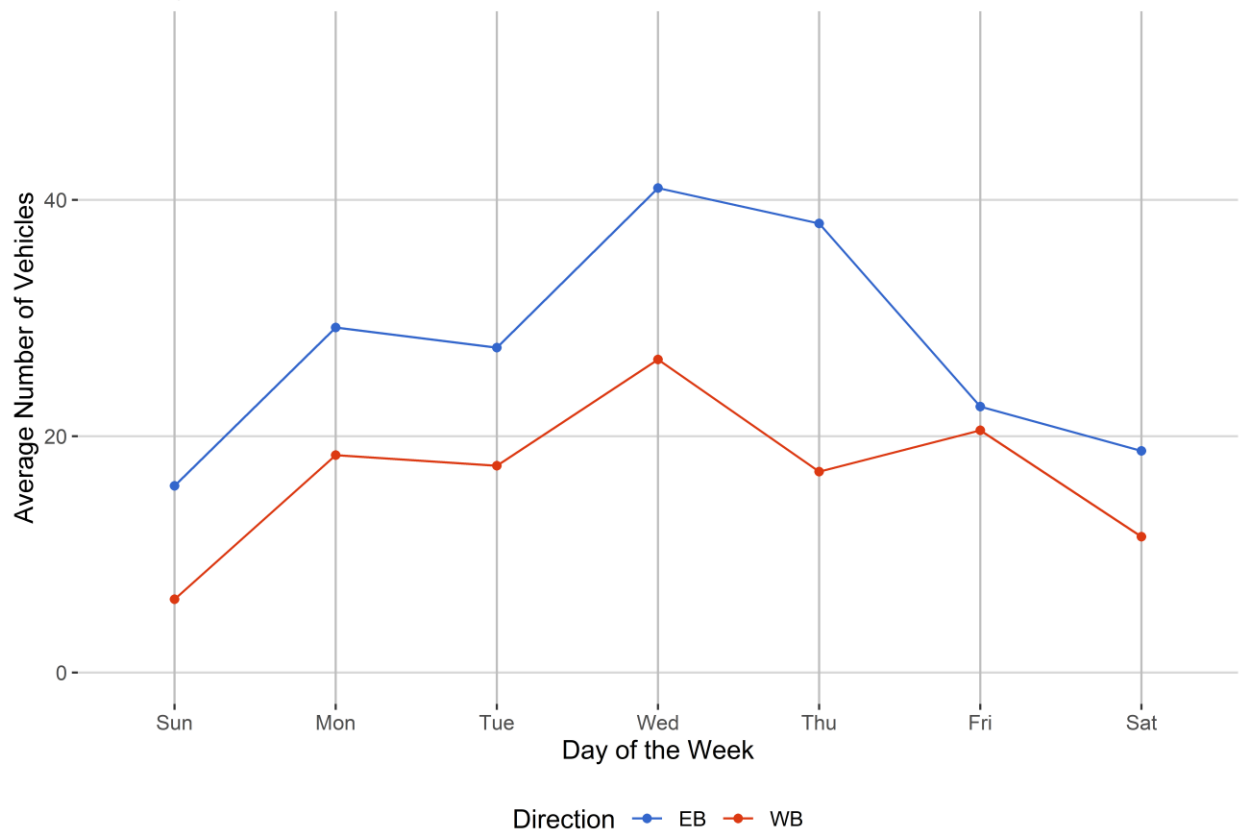


Figure 4 - Passenger Vehicles
vs. Hour of the Day

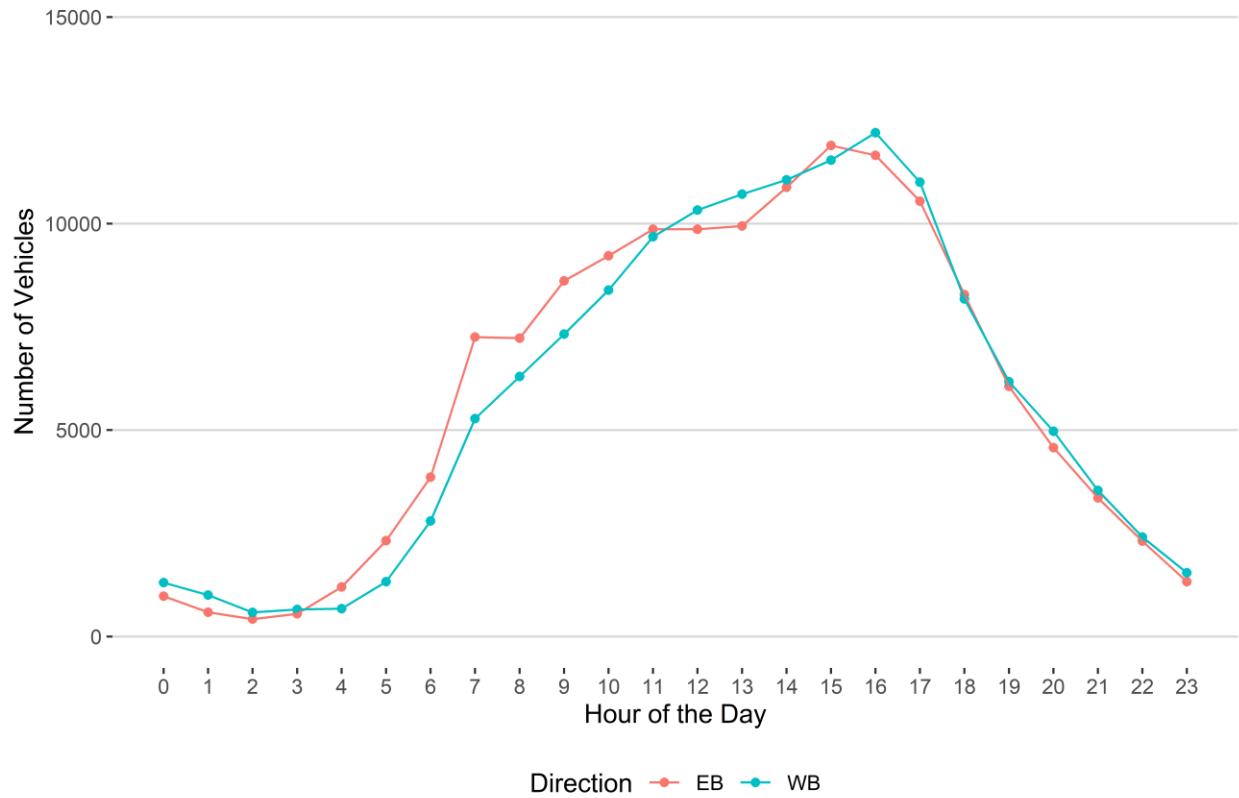


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

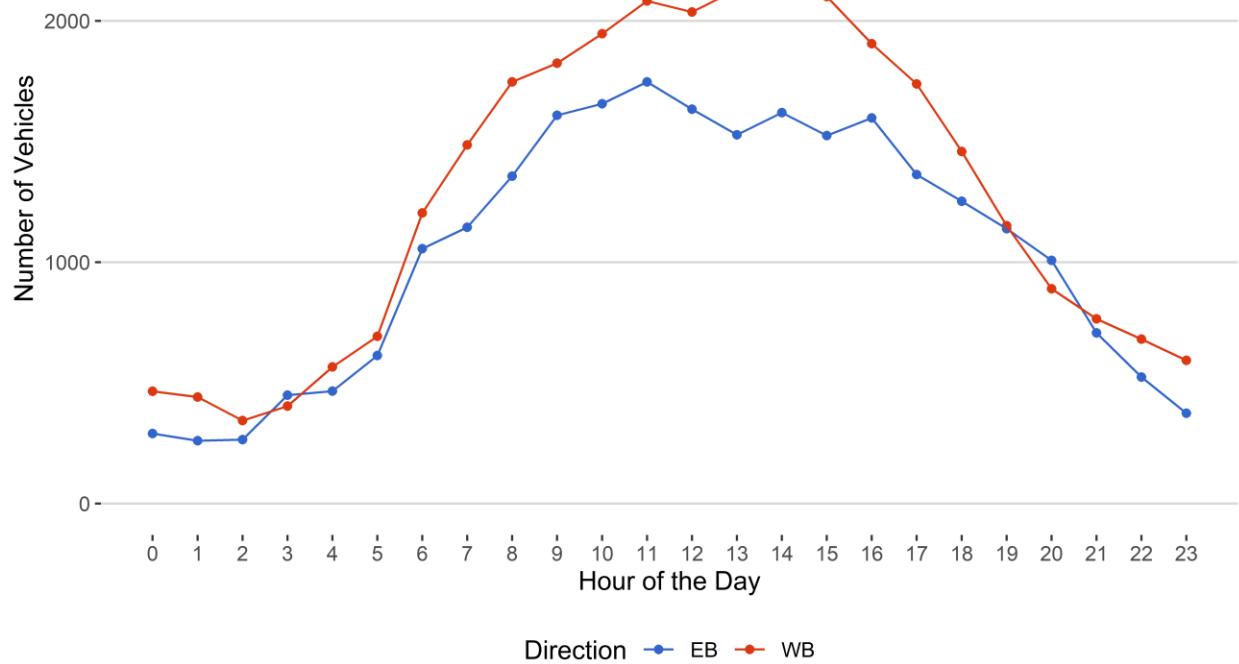


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

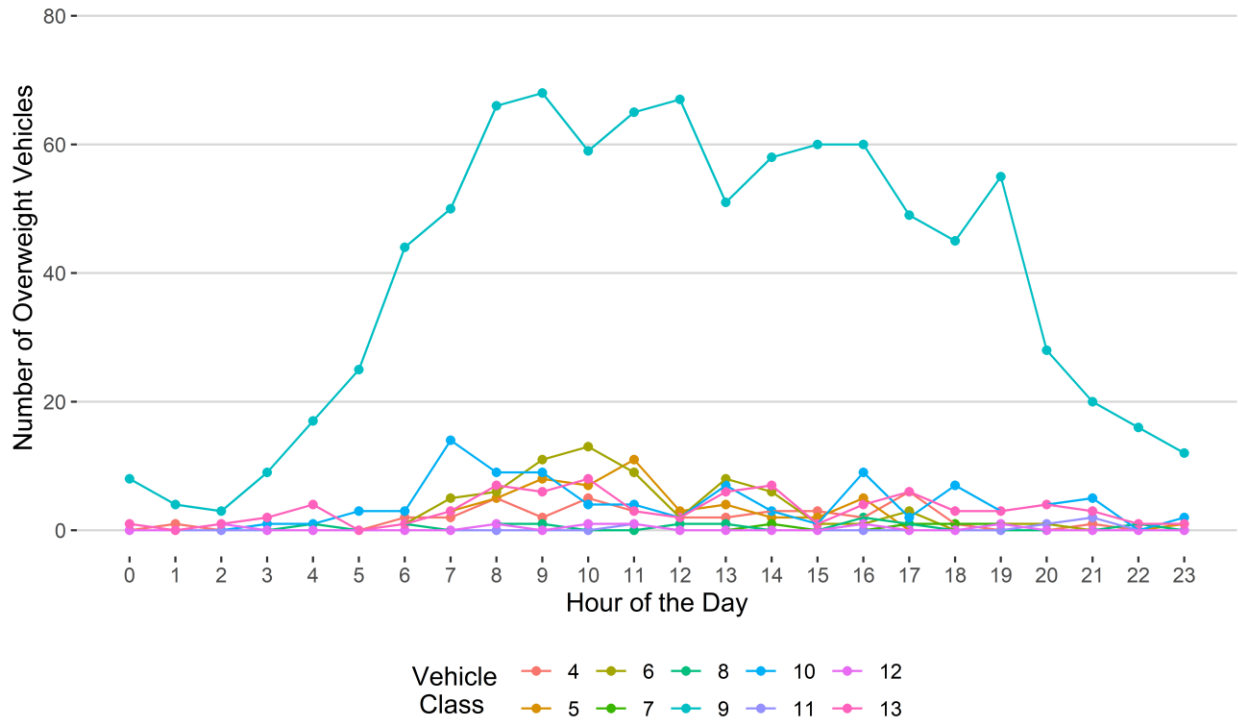


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

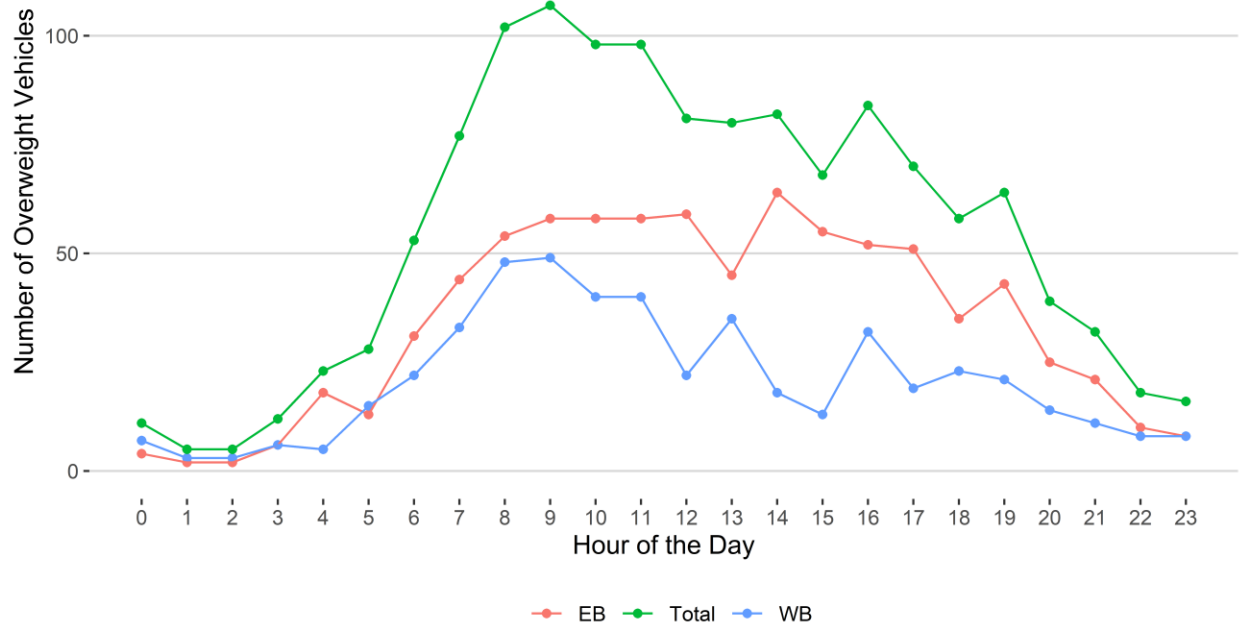
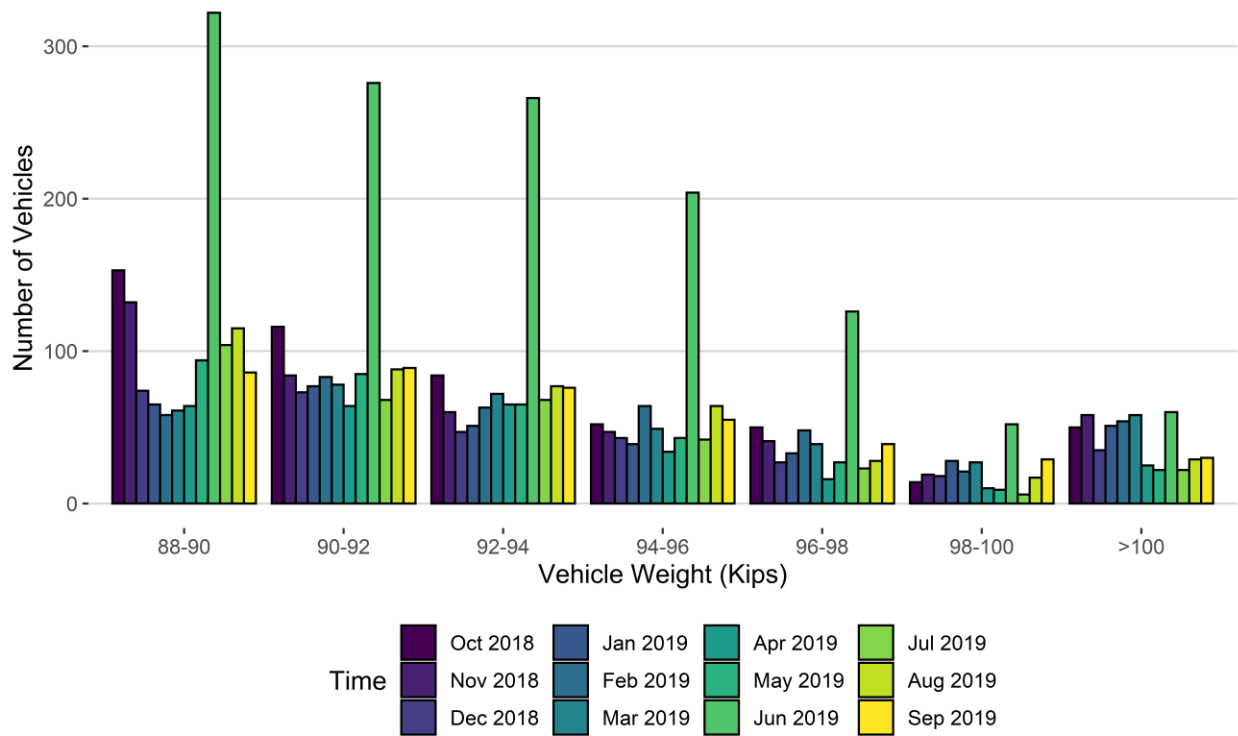
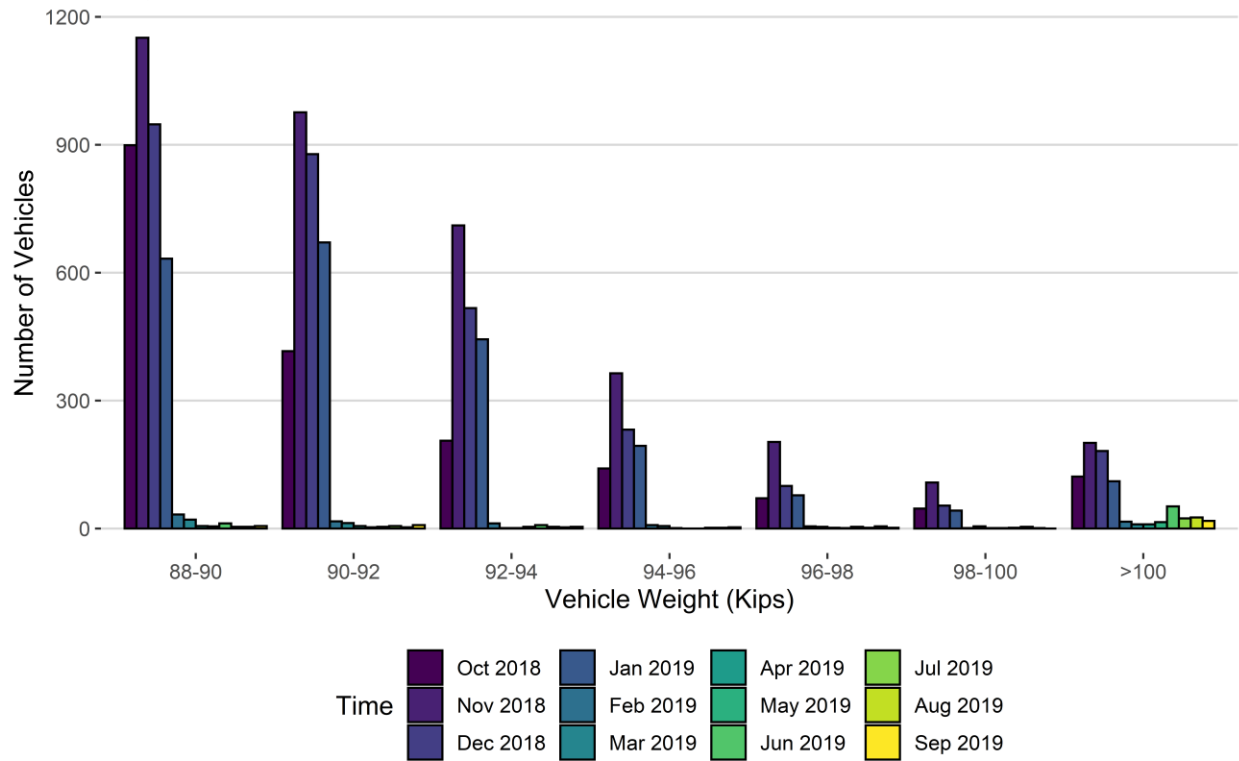


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019
88-90	153	132	74	65	58	61	64	94	322	104	115	86
90-92	116	84	73	77	83	78	64	85	276	68	88	89
92-94	84	60	47	51	63	72	65	65	266	68	77	76
94-96	52	47	43	39	64	49	34	43	204	42	64	55
96-98	50	41	27	33	48	39	16	27	126	23	28	39
98-100	14	19	18	28	21	27	10	9	52	6	17	29
>100	50	58	35	51	54	58	25	22	60	22	29	30
Total	519	441	317	344	391	384	278	345	1306	333	418	404

Figure 8 - Histogram of WB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019
88-90	899	1151	948	633	33	21	6	5	12	4	4	6
90-92	416	976	878	671	17	13	6	3	4	6	3	8
92-94	206	711	517	444	12	1	1	4	8	4	3	4
94-96	141	364	232	194	8	6	1	0	0	2	2	3
96-98	71	203	100	78	5	4	2	1	4	2	5	2
98-100	47	108	54	42	1	5	1	1	2	4	1	0
>100	122	201	182	111	16	10	10	15	52	24	26	18
Total	1902	3714	2911	2173	92	60	27	29	82	46	44	41

Figure 8 - Class 9's and 10's by Direction
vs Gross Vehicle Weight

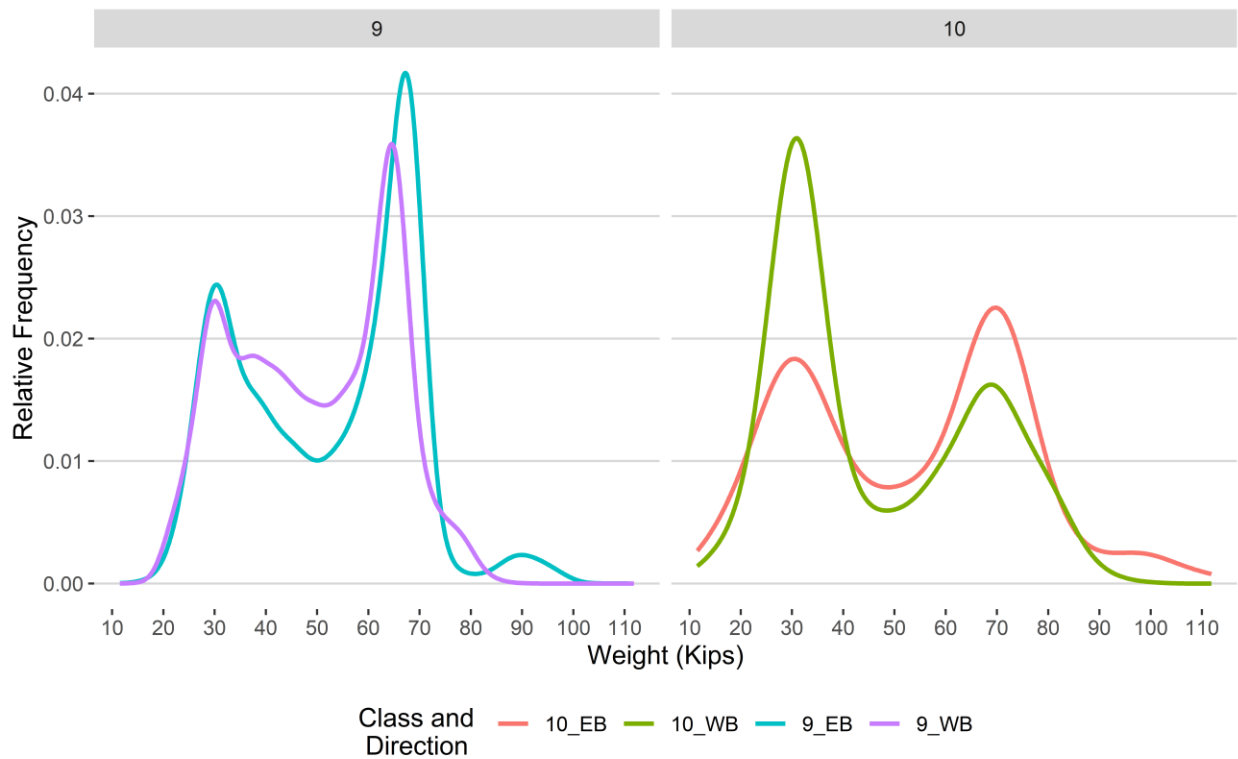


Figure 9 - Freight Percentage
by Direction and Class

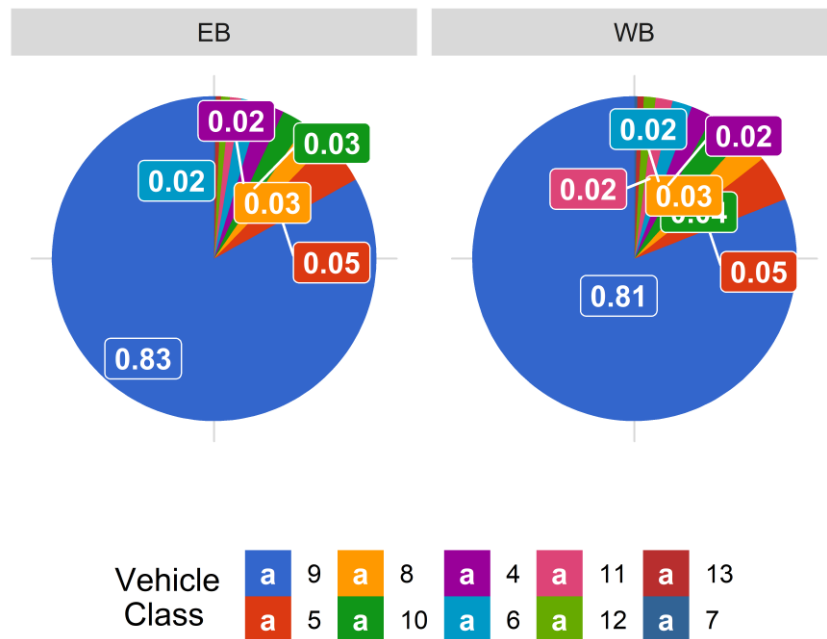


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

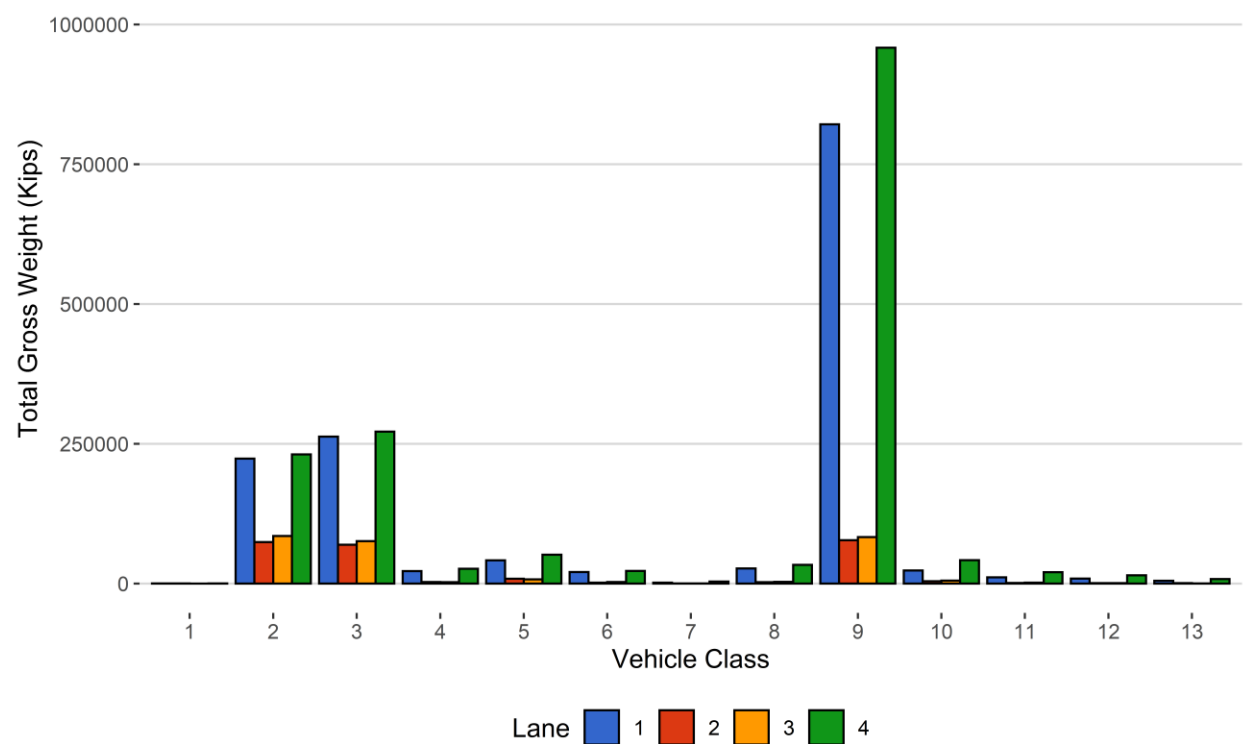


Figure 11 - Total Gross Vehicle Weight t

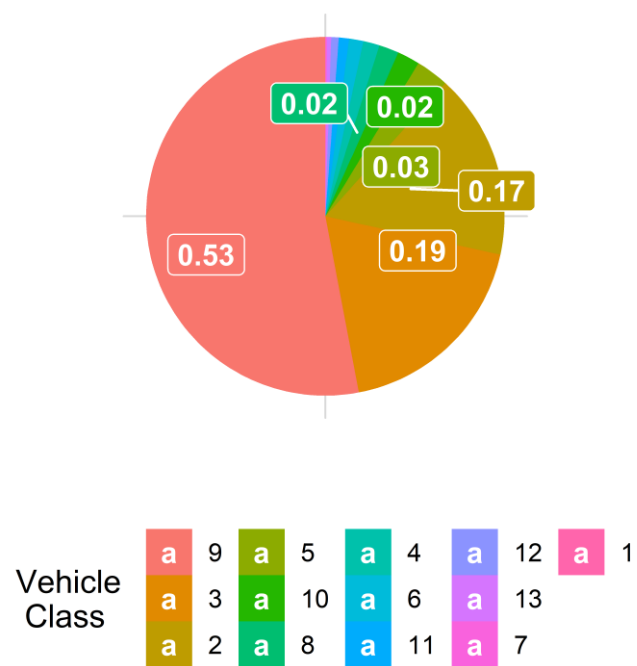


Figure 12 - Total ESALs by Class and Lane

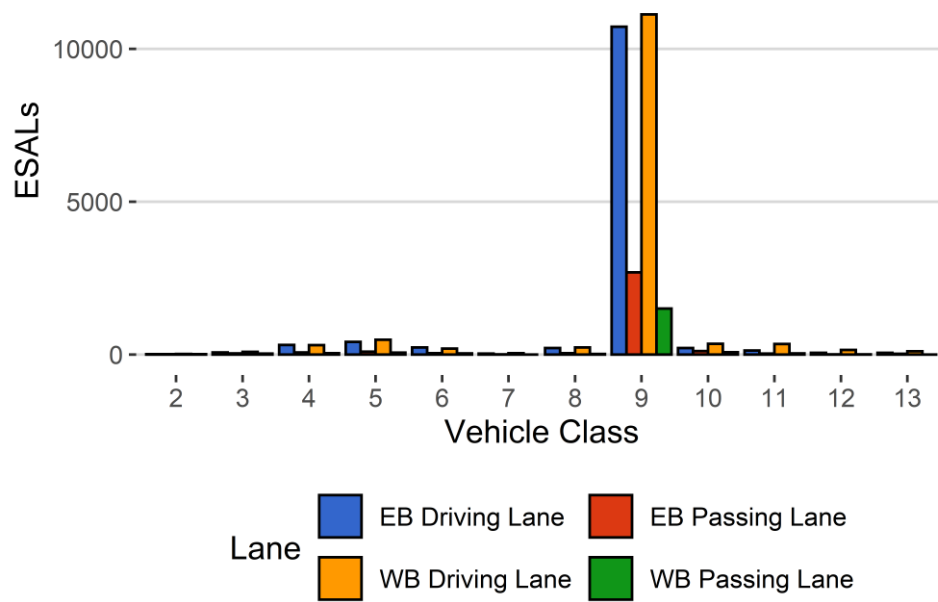


Figure 13 - ESALs by Class

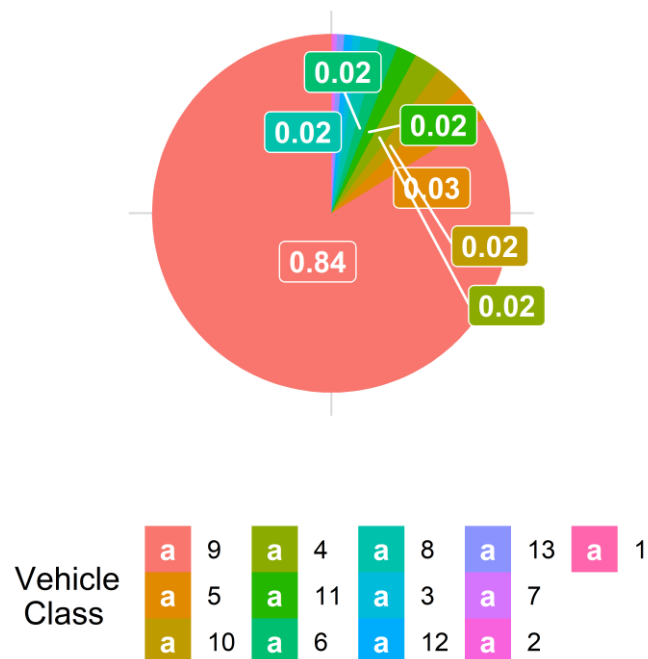


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 3 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 4 (kips)</i>	<i>Front Axle +/- 9%</i>
February 2019	9.78	0.00	13.14	0.00	12.28	0.00	9.93	0.00
March 2019	9.78	-0.06	12.98	-1.23	11.86	-3.43	9.62	-3.12
April 2019	9.58	-2.02	12.65	-3.73	11.62	-5.38	9.44	-4.90
May 2019	9.44	-3.53	12.55	-4.49	11.42	-7.04	9.31	-6.28
June 2019	9.38	-4.15	12.80	-2.59	11.42	-7.00	9.24	-6.91
July 2019	9.35	-4.36	12.66	-3.67	11.39	-7.25	9.26	-6.76
August 2019	9.48	-3.09	12.75	-2.99	11.48	-6.53	9.33	-6.05
September 2019	9.53	-2.59	12.83	-2.32	11.50	-6.37	9.52	-4.10

Table 2 Vehicle Classification Data

<i>Vehicle Class</i>	<i>Monthly Average Daily Volume</i>	<i>Monthly Total Volume</i>	<i>Monthly Total Volume Percentage</i>	<i>Monthly Total Overweight Vehicles</i>	<i>Monthly Total Overweight Percentage</i>
1	4	111	0	0	0
2	5988	179639	50	0	0
3	4009	120264	33.5	0	0
4	79	2370	0.7	40	3.1
5	294	8829	2.5	54	4.2
6	67	2014	0.6	68	5.2
7	5	161	0	6	0.5
8	85	2553	0.7	10	0.8
9	1350	40492	11.3	939	72.3
10	54	1615	0.4	94	7.2
11	24	708	0.2	4	0.3
12	16	485	0.1	6	0.5
13	6	183	0.1	77	5.9
TOTAL	11981	359424	100	1298	100

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

<i>Date</i>	<i>Day of Week</i>	<i>Time</i>	<i>Vehicle Class</i>	<i>Direction</i>	<i>Lane</i>	<i>GVW (lbs)</i>
2019-09-25	Wednesday	07:05:23	10	WB	4	141.9
2019-09-07	Saturday	21:33:43	9	WB	4	129.4
2019-09-30	Monday	23:24:24	9	WB	4	125.86
2019-09-03	Tuesday	08:20:31	9	WB	4	122.74
2019-09-13	Friday	11:25:08	9	WB	4	120.89
2019-09-30	Monday	12:08:06	9	EB	2	112.33
2019-09-10	Tuesday	23:00:56	10	EB	2	111.84
2019-09-23	Monday	16:28:03	10	EB	2	111.01
2019-09-11	Wednesday	18:53:30	10	EB	2	110.72
2019-09-17	Tuesday	08:54:00	9	WB	4	110.38

Table 4 Freight Summary

<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	EB	15	1017	169	16.6	22799	2112	5039
5	EB	8	3913	987	25.2	43197	6747	9895
6	EB	19	862	325	37.7	16838	5272	3317
7	EB	11.5	58	0	0	1828	0	580
8	EB	31	1071	719	67.1	13066	16437	1077
9	EB	33	17222	3559	20.7	797422	101587	173271
10	EB	33.5	513	150	29.2	23315	3986	5577
11	EB	36.5	273	102	37.4	8960	3106	1359
12	EB	36.5	193	26	13.5	8610	838	1257
13	EB	31.5	65	0	0	5574	0	1764
TOTAL	****	****	25187	6037	****	941610	****	203138
<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	WB	15	1218	255	20.9	25528	3249	5541
5	WB	8	4412	874	19.8	52495	6217	12095
6	WB	19	1037	367	35.4	19276	6012	3273
7	WB	11.5	94	1	1.1	3604	10	1267
8	WB	31	1336	970	72.6	13525	22656	1089
9	WB	33	20959	4205	20.1	923130	118325	185124
10	WB	33.5	1010	452	44.8	33901	13016	7604
11	WB	36.5	395	19	4.8	21330	394	3803
12	WB	36.5	264	8	3	14971	169	2814
13	WB	31.5	108	4	3.7	8171	93	2448
TOTAL	****	****	30833	7155	****	1115931	****	225059
GRAND TOTAL	****	****	56020	13192	474	2057541	310226	428197

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>EB Driving Lane</i>	<i>EB Passing Lane</i>	<i>WB Passing Lane</i>	<i>WB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>
1	48	14	5	53	120	0
2	223509	74035	84855	230995	613395	16.8
3	262879	69438	75882	271632	679832	18.6
4	22193	2718	2436	26340	53687	1.5
5	41333	8612	7293	51418	108656	3
6	20578	1532	2673	22615	47397	1.3
7	1653	175	133	3481	5442	0.1
8	26990	2514	2881	33300	65684	1.8
9	821521	77488	82985	958471	1940464	53
10	23230	4071	5199	41718	74218	2
11	11091	975	1490	20234	33790	0.9
12	8867	581	615	14525	24588	0.7
13	4822	752	279	7986	13839	0.4
TOTAL	1468713	242907	266725	1682769	3661114	100
GVW/LANE	40.12	6.63	7.29	45.96	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>EB Driving Lane</i>	<i>EB Passing Lane</i>	<i>WB Passing Lane</i>	<i>WB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0	0	0.0094
2	15	13	12	23	64	0.21	8e-04
3	73	39	31	90	233	0.75	0.0041
4	317	70	48	311	747	2.4	0.67
5	417	100	65	487	1068	3.44	0.26
6	238	48	41	199	525	1.69	0.56
7	32	8	5	50	94	0.3	1.23
8	215	45	23	235	518	1.67	0.43
9	10725	2690	1506	11128	26048	83.85	1.37
10	219	117	79	358	773	2.49	1.02
11	133	32	42	352	559	1.8	1.67
12	61	10	10	151	232	0.75	1.02
13	60	28	3	111	202	0.65	2.25
TOTAL	12505	3202	1864	13494	31066	100	10
ESALS/LANE	40.3	10.3	6	43.4	100	-	-

Table 7 Site Summary: Volume and Vehicle Class

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCAD T</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>	<i>Heavy Commercial Vehicles in Driving Lane %</i>	<i>Heavy Commercial Vehicles in Passing Lane %</i>
Oct 2018	343352	11076	1957	282691	82.3	60660.8	17.7	90.5	9.5
Nov 2018	304874	10162	1707	253655	83.2	51219.4	16.8	92	8
Dec 2018	249836	8615	1330	208619	83.5	41216.7	16.5	91.7	8.3
Jan 2019	237632	7666	1585	188493	79.3	49138.8	20.7	93.6	6.4
Feb 2019	203760	7277	1529	160956	79	42803.6	21	92.4	7.6
Mar 2019	275186	8877	1710	222175	80.7	53010.7	19.3	93.1	6.9
Apr 2019	290206	9674	1771	237070	81.7	53135.6	18.3	92.9	7.1
May 2019	360874	11568	1847	303630	84.1	57244.3	15.9	91.7	8.3
Jun 2019	400718	13357	2006	340534	85	60184.1	15	89	11
Jul 2019	427176	13874	1976	365919	85.7	61256.9	14.3	91.6	8.4
Aug 2019	435975	13961	2028	373117	85.6	62857.5	14.4	91.3	8.7
Sep 2019	359424	11974	1980	300014	83.5	59410.2	16.5	92	8
TOTAL	3889013	-	-	3236873	-	652138	-	-	-
AVERAGE	324084	10673	1786	269739	83	54345	17	92	8

###ESALS

<i>Month</i>	<i>ESALS EB Passing Lane</i>	<i>ESALS EB Driving Lane</i>	<i>ESALS WB Driving Lane</i>	<i>ESALS WB Passing Lane</i>	<i>Total ESALS</i>	<i>Driving Lane ESALS %</i>	<i>Passing Lane ESALS %</i>	<i>Pavement Life Decrease Months</i>
Oct 2018	23230	4308	2613	40888	71039	90	10	19.1
Nov 2018	20520	2451	2346	36773	62090	92	8	45.4
Dec 2018	12572	2548	2315	27559	44994	89	11	44.8
Jan 2019	15427	2515	2039	26307	46288	90	10	35.2
Feb 2019	11829	3709	2133	13009	30680	81	19	0.4

Mar 2019	14419	2617	1904	14178	33118	86	14	0.5
Apr 2019	12589	3407	1777	12322	30096	83	17	0.3
May 2019	11950	3256	1712	12107	29025	83	17	0.1
Jun 2019	23167	11821	3770	23583	62341	75	25	0.1
Jul 2019	12316	3275	1958	11890	29439	82	18	0.1
Aug 2019	12933	3646	2141	12756	31476	82	18	0.1
Sep 2019	12528	3209	1874	13878	31489	84	16	0.2
TOTAL	183481	46759	26583	245252	502076	-	-	-
AVERAGE	15290	3897	2215	20438	41840	85	15	12

###Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Passing Lane</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Oct 18	1717957	290836	276910	2210236	4495940
Nov 18	1554196	195512	237763	1815173	3802644
Dec 18	1297542	166610	203153	1450218	3117523
Jan 19	1318897	132672	166003	1612384	3229956
Feb 19	1052899	129123	157838	1259469	2599329
Mar 19	1361595	164259	199086	1585945	3310885
Apr 19	1325756	180407	211379	1556974	3274517
May 19	1423938	260130	265009	1700873	3649951
Jun 19	2939660	809623	639308	3533060	7921650
Jul 19	1616775	307221	340173	1791764	4055932
Aug 19	1640953	322458	343031	1861861	4168303
Sep 19	1473408	243119	267034	1684716	3668276
TOTAL	18723574	3201970	3306687	22062673	47294905
AVERAGE	1560298	266831	275557	1838556	3941242

###Overweight Vehicles

<i>Month</i>	<i>Total Number of Overweight Vehicles</i>	<i>Overweight / Total Volume</i>	<i>Overweight / Heavy Commercial Volume</i>	<i>Number Over 88,000 lbs</i>	<i>Number Over 98,000 lbs</i>
Oct 2018	13380	4.1	22.9	2426	234
Nov 2018	11759	4.1	24.3	4157	387
Dec 2018	6713	2.7	16.2	3230	289
Jan 2019	5490	2.4	11.7	2523	234
Feb 2019	1777	0.9	4.4	487	93
Mar 2019	1390	0.5	2.7	447	100
Apr 2019	958	0.3	1.9	306	47
May 2019	1034	0.3	1.9	374	47
Jun 2019	3062	0.4	2.6	1390	166

Jul 2019	1028	0.2	1.7	380	56
Aug 2019	1195	0.3	1.9	462	73
Sep 2019	1311	0.4	2.3	446	77
TOTAL	49097	-	-	16628	1803
AVERAGE	4091.4	1.4	7.9	1385.7	150.2

###Freight

<i>Month</i>	<i>EB Freight Tons</i>	<i>WB Freight Tons</i>	<i>Total Freight</i>	<i>EB Freight %</i>	<i>WB Freight %</i>
Oct 2018	295906	409353	705259	42	58
Nov 2018	249601	342900	592501	42.1	57.9
Dec 2018	189465	263947	453412	41.8	58.2
Jan 2019	214358	285394	499753	42.9	57.1
Feb 2019	169293	197643	366936	46.1	53.9
Mar 2019	210425	229917	440342	47.8	52.2
Apr 2019	195045	212731	407776	47.8	52.2
May 2019	198928	211636	410564	48.5	51.5
Jun 2019	440455	421133	861588	51.1	48.9
Jul 2019	208712	210195	418907	49.8	50.2
Aug 2019	214388	225896	440283	48.7	51.3
Sep 2019	203138	225059	428197	47.4	52.6
TOTAL	2789714	3235802	6025516	-	-
AVERAGE	232476.2	269650.2	502126.4	46.3	53.7